organized in sets of two characters **43**, with an even number of characters around cylinder **27**. Aperture **39** through which the user feels the Braille characters on display surface **33** of cylinder **27** is preferably of a width to allow no more than two characters to be felt at one time. With a six-dot Braille code, up to twelve actuators are used to control two character cells (depending upon design choice). For eight-dot code, up to sixteen actuators are used. At any given instant, all two character cell pairs around cylinder **27** are displaying the same pattern. Therefore, only twelve actuators are needed to control all cells **41** on cylinder **27**, with the motion from each actuator distributed to the corresponding Braille dot mechanism in all cells. The actuators are controlled by a computational device so that what the user feels through aperture **39** is a string of Braille characters. The actuators must therefore be fast enough to change the pattern of dots on a serial basis to provide the desired reading speed.

The method of distribution of actuator activity to its multiple corresponding dots may be by flexible cable directed through a channel, by solid linkages, or by a combination of the two. The greater the number of cells (character pairs) on cylinder **27**, the flatter reading surface **33** will seem to the user, but such an increase will also increase the size of the device, and the force the twelve actuators must provide to operate all the cells. The number of cells on cylinder **27** will be set by a design compromise of these factors.

As illustrated in FIG. **2**, in an embodiment employing external actuator assembly **45** statically positioned at a station **47** of housing **37**, cylinder **27** contains no active components. The pattern of dots making up Braille characters is set in cooperation with surface characteristic **31** of cylinder **27** by external actuators **49** in assembly **45** (only one shown) before they move into reading aperture **39** for detection by the user. In this embodiment, six dots (for six-dot Braille code, arranged in two columns of three dots each) form each Braille cell (i.e., one character in six-dot Braille), and dots are arranged around display surface **33** in three endless rows (see FIG. **1** for an example of this arrangement of rows, it being understood that for eight-dot Braille code eight dots arranged in two columns of four dots each form a cell, there being four endless rows arranged around display surface **33**). This allows the reader apparatus of this invention to operate with as few as three actuators **49** in the assembly creating a stream of Braille characters at reading aperture **39** as relative motion between surface **33** and actuator station **47** (in a direction substantially parallel to one another) continues. This represents a substantial reduction compared to the hundreds of actuators that may be required for existing readers (a slight increase in the number, for example to six actuators, may allow slower actuators to be used, by splitting the task of setting the dots).

There are several ways by which the Braille dots may be formed at display surface **33** (i.e., defining a selected surface characteristic **31**) of cylinder **27** by actuators **49**. The individual dots may be defined by numerous (one for each dot) spring-loaded push-on, push-off pin devices mounted in openings (corresponding to the dots) in cylinder **27** such as are used in certain push-button switches or in retractable ball-point pens. A push from an actuator shaft **51** causes an individual pin to switch state, from "in" (not extended from the cylinder surface) to "out" (extended from the cylinder surface), or vice versa. The controlling device preferably keeps track of the status of every dot in every cell on the cylinder, and when refreshing the text either reverses the status of dots or allows them to remain unchanged on a dot-by-dot basis, according to the requirements of the new text (though refreshing could occur merely by returning all pins to a default state after reading, for example the unextended position, by mechanical means before resetting by actuators **49** as discussed hereinafter).

Other passive mechanical means of forming the dots could be utilized. For example, pins shaped as small cylinders or spheres which are flattened on one side and which can be rotated about individual axes in openings in the cylinder by the actuators could be utilized. The cylinders or spheres would be shaped and contained so that rotation while passing across the user reading area and when being contacted by the user's fingers is prevented.

In yet another embodiment, the selected surface characteristic **31** of cylinder **27** can be a mechanically plastic material covering outer surface **33** of cylinder **27** and into which actuators **49** press a pattern of Braille text characters as it moves past, and which is capable of such character retention through reading area (or aperture) **39**. After passing reading area **39**, rollers or similar such devices are provided to flatten (and thus reshape so that no impressions remain) the surface of the plastic material, thereby providing a blank, unwritten, surface **33** for new text to be written. The plastic material must be sufficiently stiff to permit reading without undue deformation of the material, but sufficiently pliable to permit writing, flattening, and rewriting.

In still another embodiment, shown in FIG. **3**, the Braille dots are externally set in a mechanically plastic material as described above with respect to FIG. **2**, but instead of being set on surface **33** of wheel **27**, they are set on surface **55** of belt **57** moving around two wheels **59** and **61**. Instead of one or two characters being exposed at any given time at reading aperture **39**, several characters, up to an entire line of Braille text, are exposed. Back plate **63** keeps belt **57** from flexing while the user reads the Braille at reading aperture **39**. This method sacrifices some simplicity for the ability to display an entire line at a time.

The user may choose to operate such a display in any of several different modes. The display can be configured to update continuously and with wheels **59**/**61** rotating continuously. The user places a finger where the text first appears, and stops the motion of the display in order to re-read characters that have just moved past the finger. Alternatively (depending upon reading aperture size), the display can be configured to update an entire line at a time, and is then stopped while the user reads the entire line. When deploying the display apparatus of this invention in this mode, belt **39** can be made wider, and more actuators **49** can be added, so more than one line can be displayed at a time if desired. With a sufficiently long line of actuators and a sufficiently wide belt, an entire page of Braille text can be updated and displayed at once.

Moreover, where a multiple-line extended Braille text display is desired, separate belts **57** (and drive wheels **59**/**61**) may be provided for each line of text. This would allow for utilization of much slower actuators **49**. While the user is reading one line, other lines are slowly being updated. Satisfactory throughput can be provided even if the individual actuator groups in assembly **45** (triads, for example, for six-dot Braille) produce Braille text at a fraction of the user's reading speed.

FIG. **4** shows an example of one method of implementation of refreshable Braille reader **65** in accord with the various embodiments of this invention. This implementation includes interface and control logic **69**, power electronics **71** to drive the transducers (actuators) and rotation of Braille wheel **27**, and physical user interface **73**. The physical user